Field Evaluation of Cotton in Puerto Rico for Pink Bollworm Resistance

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ABSTRACT

During a 3-year period, 1974-76, 267 primitive cottons, *Gossypium* spp., were field evaluated in Puerto Rico for natural resistance to pink bollworms, *Pectinophora gossypiella* (Saunders). Eight lines (T-55, T-58, T-170, T-228, T-331, T-378, T-610, T-668) had significantly less seed damage than the check cultivars included in each test. Several other lines were selected for retesting based on an outstanding performance during at least one of the growing seasons.

KEYWORDS: Host plant resistance, *Gossypium* spp., pink bollworm, cotton, *Pectinophora gossypiella* (Saunders), race stocks, photoperiodic, *latifolium*, *palmeri*, insect-plant relationships, *Gossypium hirsutum*.

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FIELD EVALUATION OF COTTON IN PUERTO RICO FOR PINK BOLLWORM RESISTANCE

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INTRODUCTION

The pink bollworm (PBW), *Pectinophora gossypiella* (Saunders), is a worldwide pest of cotton (*Gossypium* spp.). In the United States, it is the major pest in the desert cotton-growing areas of Arizona and southern California. At present, PBW is controlled by spraying fields with insecticides every 5 to 7 days.

One alternative or adjunct to chemical control is the development of resistant cultivars. A genetic source of resistance would enable the grower to reduce or perhaps even eliminate chemical control of the insect. Since 1971, we have tested many cotton germplasm sources to find genetic resistance to PBW. A rich source is the collection of primitive race stocks (Texas race stocks) of *Gossypium hirsutum* L., maintained at College Station, Tex., under the direction of the U.S. Department of Agriculture, Cooperative States Research Service Regional Research Project S-77.[2]

A major problem is that approximately 80 percent of the race stocks are photoperiodic and thus will not flower and set bolls in Arizona during the field season. We could screen only small numbers of photoperiodic stocks in the greenhouse during the short days of the winter season. Therefore, we decided to consider field testing in Puerto Rico.

At one time, PBW had been the most important factor limiting production of cotton on the island[3] and was considered to be the main reason for the decline and eventual termination of its cotton industry (E. G. Stone, personal communication). It was hoped that the stands of "wild" cotton still growing throughout the island would harbor PBW and thus provide a natural source of infestation. A field trip to Puerto Rico in May 1974, revealed the presence of PBW in wild cotton at over 20 sites. We thus concluded that the island would provide suitable conditions for field screening of the photoperiodic race stocks.

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[2]Anonymous. The regional collection of *Gossypium* germplasm. U.S. Dept. Agr., Agr. Res. Serv. ARS H-2, 105 pp. 1974.

[3]Martorell, L.F. Cotton pink bollworm control in Puerto Rico. P.R. Agr. Exp. Stn. Bull. 93, 40 pp. 1951.

Herein, we report our results of 3 years of testing the photoperiodic race stocks near Isabela in northwestern Puerto Rico.

MATERIALS AND METHODS

In all three seasons, cottonseed was hand-planted in August in single rows 7.6 m long; rows were 1 m apart. In 1974, the commercial cultivar 'Deltapine 16' (DPL-16) and 72 race stocks were planted in two replications. In 1975 and 1976, DPL-16 and 124 and 103 race stocks, respectively, were planted in four replications. The plants were thinned to 15 to 20 cm apart when they were 15 to 30 cm tall. Standard cultural practices for the location were followed except that no insecticides were used.

In November 1974, inspection of green bolls revealed low infestations of PBW. Therefore, infested bolls were harvested from a stand of wild cotton and spread in the test plots to insure an adequate insect infestation. This practice was also followed in 1975 and 1976.

The first season, all the seed cotton from 10 plants per row was harvested in March. The second and third seasons, seed cotton was harvested from 10 plants per row sequentially at about 2-week intervals, beginning February 3, 1976, and January 18, 1977. Seed cotton was forwarded to Phoenix through the USDA Plant Inspection Station, Beltsville, Md. Seed cotton was ginned, and 300 to 500 seeds from each plot were X-rayed.[4] Seed damage by PBW was expressed as the percentage of damaged seeds in the total sample.

RESULTS

Table 1[5] lists in numerical order the 267 Texas race stocks that were field tested in Puerto Rico for three seasons, 1974-75 to 1976-77. Twenty-six race stocks were tested for two seasons, and two were tested all three seasons.

Table 2 lists race stocks selected from the 1974-75 test. Ten race stocks had significantly less seed damage than the DPL-16 check. Texas 55, although not listed, had slightly less damage in 1974-75 and significantly less damage in at least some harvests in the two subsequent seasons (tables 3 and 4).

Table 3 presents seed damage data from three harvests of the cultivar and the 12 race stocks selected in 1975-76. It was impractical to run a combined analysis on the large number of entries because of limited computer capability. Therefore, we arbitrarily selected only race stocks that had $\leq$67 percent as much seed damage as DPL-16.

No race stock had less seed damage than the cultivar at all three harvests; however, two race stocks, T-170 and T-612, had consistently lower damage than the check at all three harvests even though their means were slightly too high

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[4] Wilson, R. L., and Wilson, F. D. Comparison of an X-ray and a green-boll technique for screening cotton for resistance to pink bollworm. J. Econ. Entomol. 68: 636-638. 1975.

[5] Tables begin on p. 5.

to satisfy our selection criterion. Five race stocks had less damage than DPL-16 at two of the three harvests. Texas 58, T-245, T-620, and T-636 had as much damage as DPL-16 at first harvest but considerably less at third harvest, reflecting a lower rate of increase in damage.

Table 4 shows seed damage in the 34 race stocks selected in 1976-77 because they had significantly less seed damage than the check in at least two harvests. Nine race stocks had significantly less damage than DPL-16 at the second, third, and fourth harvests (first harvest data are not presented because race stocks were not significantly different from the check). Fifteen race stocks had less damage than DPL-16 at two of the three harvests. Another nine had less damage than DPL-16 at fourth harvest, but not at earlier harvests, again indicating a lower increase in rate of damage. Ten late-maturing race stocks had considerably less seed damage at fifth harvest than the cultivar had shown at fourth harvest (fifth harvest data from the cultivar were not available).

Table 5 lists eight race stocks that had more seed damage than DPL-16 in 1974-75 and 1975-76. None had significantly more seed damage than the check cultivar in 1976-77.

DISCUSSION AND CONCLUSIONS

The field tests in Puerto Rico identified several race stocks that may be used in our breeding program to develop cotton cultivars resistant to PBW. These race stocks may be categorized as follows: (1) Selected all three seasons: T-55; (2) selected both seasons they were tested: T-58, T-170, T-228, T-331, T-378, T-610, T-668; (3) selected only one of the two seasons they were tested: T-127, T-158, T-197, T-257, T-273, T-302, T-303, T-330, T-570, T-635, T-679; and (4) selected on the basis of low seed damage at a late harvest: T-20, T-31, T-48, T-102, T-175, T-197, T-198, T-245, T-620, T-636, T-763. In addition, 27 race stocks were selected in the one season they were tested and should be tested again.

Most of the cottons listed above belong to the *G. hirsutum* group known as race *latifolium*. We have concentrated our efforts on this group because it is most closely related to commercial cultivars. Presumably, transfer of PBW resistance will be more easily accomplished by using *latifolium* race stocks than by using more refractory ones, such as in race *palmeri*, represented by T-302, T-303, T-330, and T-331.

Even the *latifolium* race stocks, however, vary significantly in photoperiodic response and in agronomic characters and fiber properties. Our challenge will be to identify those that combine best with cultivars and that will lead to the best products for future breeding efforts. An additional challenge will be to identify the mechanisms of resistance so that we can effectively select for resistance in segregating plant progenies.

Development of PBW-resistant cultivars from unimproved germplasm will be difficult and time consuming. The results, however, should be worth the effort because resistant cultivars will not only save the grower the high cost of insecticides but will also reduce environmental contamination.

TABLES

Table 1.--*Texas race stocks tested for pink bollworm resistance in Puerto Rico, 1974-77*

Race stock	Season tested			Race stock	Season tested		
	1974-75	1975-76	1976-77		1974-75	1975-76	1976-77
Texas 2 (T-2)		X					
T-3		X		T-65			X
T-4			X	T-66		X	
T-6			X	T-68	X		
T-7			X	T-69		X	
T-8		X	X	T-70	X		X
T-10		X		T-71	X		
T-15		X		T-72			X
T-16		X		T-73			X
T-17		X		T-75		X	
T-20		X		T-76	X		
T-21			X	T-77	X		
T-22			X	T-78		X	
T-25	X	X	X	T-79		X	
T-30		X		T-80	X		
T-31			X	T-83		X	
T-33			X	T-86	X		
T-34			X	T-87			X
T-35			X	T-89	X		
T-36			X	T-90			X
T-37			X	T-91	X		
T-39			X	T-93			X
T-40			X	T-95		X	
T-43			X	T-96			X
T-44		X		T-98		X	
T-45		X		T-99			X
T-46			X	T-101			X
T-48			X	T-102			X
T-52			X	T-103		X	
T-55	X	X	X	T-104			X
T-56			X	T-105		X	
T-57			X	T-106		X	
T-58		X		T-107			X
T-59		X		T-108		X	
T-60		X		T-109		X	
T-61		X		T-112		X	
T-62			X	T-113		X	X
T-63			X	T-114	X		
T-64			X	T-115	X		

Table 1.--*Texas race stocks tested for pink bollworm resistance in Puerto Rico, 1974-77*--Continued

Race stock	Season tested			Race stock	Season tested		
	1974-75	1975-76	1976-77		1974-75	1975-76	1976-77
T-116		X		T-180	X		
T-118	X			T-181			X
T-119		X		T-182		X	
T-120		X		T-183		X	
T-121			X	T-186	X		
T-122		X		T-195		X	
T-123			X	T-196		X	
T-124	X			T-197	X		X
T-126	X			T-198			X
T-127	X		X	T-199		X	
T-140		X		T-200		X	
T-142	X			T-201		X	
T-143		X		T-202			X
T-148	X			T-203			X
T-149	X			T-204		X	
T-150	X			T-205		X	
T-151		X		T-206	X		
T-152	X			T-208		X	
T-153		X		T-209		X	
T-154		X		T-212		X	
T-155	X			T-213	X		
T-156	X			T-214			X
T-157			X	T-215		X	
T-158		X	X	T-216		X	
T-160			X	T-217		X	
T-161		X		T-218		X	
T-162	X			T-219		X	
T-163	X			T-221		X	
T-164	X			T-222		X	
T-165	X			T-223	X	X	
T-167			X	T-224		X	
T-168			X	T-225		X	
T-169		X		T-226			X
T-170		X	X	T-227			X
T-171		X		T-228		X	X
T-172	X			T-229	X		
T-173			X	T-232		X	
T-175			X	T-233			X
T-176			X	T-234	X		
T-177		X		T-235	X		
T-178			X	T-236		X	
T-179	X			T-237	X		

Table 1.--*Texas race stocks tested for pink bollworm resistance in Puerto Rico, 1974-77*--Continued

Race stock	Season tested			Race stock	Season tested		
	1974-75	1975-76	1976-77		1974-75	1975-76	1976-77
T-239			X	T-466		X	
T-240		X		T-467	X		
T-241			X	T-469		X	
T-242			X	T-479	X		
T-243		X	X	T-482			X
T-245		X		T-488		X	
T-247		X		T-489			X
T-248	X			T-490			X
T-249			X	T-492			X
T-250		X		T-495		X	
T-253	X			T-497			X
T-257	X		X	T-498	X		
T-258		X		T-503			X
T-265	X			T-570		X	X
T-272	X			T-595		X	
T-273	X		X	T-596	X	X	
T-293			X	T-597	X		
T-294			X	T-600		X	
T-301	X			T-606	X		
T-302	X		X	T-609	X		
T-303	X		X	T-610		X	X
T-304		X		T-611		X	
T-306			X	T-612		X	
T-316			X	T-615	X		
T-321	X			T-616		X	
T-323		X		T-619		X	
T-328		X		T-620		X	
T-329	X			T-623		X	
T-330		X	X	T-627		X	
T-331	X		X	T-633	X		
T-333		X		T-634		X	
T-335		X		T-635		X	X
T-336			X	T-636		X	
T-339			X	T-640	X		
T-340		X		T-641		X	
T-344		X		T-642	X		
T-375			X	T-643	X		
T-377			X	T-644		X	
T-378	X		X	T-645		X	
T-460		X		T-646	X	X	
T-461		X		T-649	X		
T-464	X			T-664		X	

Table 1.--*Texas race stocks tested for pink bollworm resistance in Puerto Rico, 1974-77*--Continued

Race stock	Season tested			Race stock	Season tested		
	1974-75	1975-76	1976-77		1974-75	1975-76	1976-77
T-665		X		T-738		X	
T-668	X		X	T-743		X	
T-677	X			T-757		X	
T-679		X	X	T-763			X
T-682	X	X		T-764			X
T-684		X		T-775			X
T-702		X		T-960			X
T-703	X	X		T-1053			X
T-705		X		T-1125			X
T-711		X		T-1158			X
T-717		X		T-1180			X

Table 2.--*Seed damage caused by pink bollworm to the cultivar DPL-16 and 10 selected Texas race stocks grown in Puerto Rico, 1974-75*[1]

Race stock or cultivar	Mean seed damage	Race stock or cultivar	Mean seed damage
	Percent[2]		*Percent*[2]
DPL-16 (check)	33.0	T-273	15.4
T-127	13.3	T-302	13.2
T-142	17.6	T-303	15.5
T-257	16.4	T-331	11.5
T-265	8.7	T-378	13.0
T-668	13.7		

[1]Means are averages of 2 replications.
[2]Race stock mean was significantly lower than that of DPL-16 at the 0.05 level of probability.

Table 3.--*Seed damage caused by pink bollworm to a cultivar and 12 selected Texas race stocks grown in Puerto Rico, 1975-76*[1]

Race stock or cultivar	Seed damage on date indicated		
	Feb. 3	Feb. 18	Mar. 8
	Percent		
DPL-16 (check)	17.7	29.5	37.8
Texas 20 (T-20)	36.9	41.6	26.6
T-55	14.7	[2]12.5	35.0
T-58	15.5	[2]19.8	[2]13.2
T-170	13.4	19.9	28.8
T-228	[2]11.3	[2]16.5	37.6
T-245	17.5	---	[2]24.9
T-330	[2]8.6	25.2	[2] 5.9
T-610	---	[2]13.1	[2]18.8
T-612	12.1	20.7	28.9
T-620	20.7	20.8	[2]24.9
T-636	30.1	21.1	[2]22.3
T-679	[2]11.3	[2]19.2	42.0

[1]Plots replicated 4 times.
[2]Race stock mean $\leq$ 67.0 percent of the check mean.

Table 4.--*Seed damage caused by pink bollworm to a cultivar and 34 selected Texas race stocks grown in Puerto Rico, 1976-77*[1]

Race stock or cultivar	Seed damage on date indicated			
	Feb. 1	Feb. 15	Mar. 1	May 18[2]
	Percent			
DPL-16 (check)	40.4	56.7	73.2	---
Texas 6 (T-6)	33.0	46.6	[3]40.2	---
T-7	[3]26.7	[3]34.5	[3]34.1	---
T-31	38.1	41.5	37.8	---
T-48	31.2	46.6	37.6	---
T-55	[3]18.9	46.3	[3]19.7	---
T-58	[3]26.2	---	[3]18.8	---
T-65	[3]25.8	50.4	[3]45.6	---
T-99	[3]19.8	48.5	[3]40.2	---
T-102	34.6	39.1	[3]40.3	---

Table 4.--*Seed damage caused by pink bollworm to a cultivar and 34 selected Texas race stocks grown in Puerto Rico, 1976-77*[1]-- Continued

Race stock or cultivar	Seed damage on date indicated			
	Feb. 1	Feb. 15	Mar. 1	May 18[2]
	Percent			
T-158	[3]16.6	51.6	[3]38.0	---
T-160	[3]20.7	43.6	[3]36.7	---
T-168	[3]27.3	[3]37.0	[3]40.2	---
T-170	[3]21.8	[3]34.0	[3]26.3	---
T-175	30.6	46.3	[3]44.2	---
T-176	[3]26.7	40.4	[3]47.2	---
T-181	[3]23.9	[3]33.4	[3]39.3	42.9
T-197	37.3	56.3	[3]42.6	---
T-198	28.4	50.1	[3]46.8	---
T-202	29.2	[3]34.6	[3]37.6	---
T-228	[3]22.6	38.5	[3]42.3	---
T-316	[3]19.4	[3]19.3	---	39.4
T-331	---	---	[3]10.1	43.3
T-377	[3]20.4	[3]28.9	[3]14.3	45.6
T-378	---	[3]30.0	---	45.8
T-489	[3]17.8	49.8	[3]26.8	39.2
T-497	[3]23.6	47.4	[3] 9.5	42.0
T-503	[3]27.8	[3]35.9	[3]34.1	---
T-570	[3]16.1	[3]29.6	[3]40.5	---
T-610	[3]17.4	[3]36.8	[3]11.0	---
T-635	[3]22.6	[3]35.8	[3]44.0	---
T-668	[3]26.8	38.4	[3]35.8	42.7
T-763	29.9	53.7	[3]34.6	---
T-1053	[3]24.4	[3]40.0	51.2	56.6
T-1180	[3]19.6	[3]24.5	---	42.1

[1]Plots replicated 4 times.
[2]Seed damage not available for the check cultivar.
[3]Race stock mean significantly lower than that of DPL-16 at the 0.05 level of probability.

Table 5.--*Seed damage in Texas race stocks higher than that in the check cultivar*

Race stock or cultivar	Seed damage, season, and harvest			
	1974-75	1975-76		
	1	1	2	3
	Percent			
DPL-16 (check)	33.0	17.7	29.5	37.8
Texas 2 (T-2)	---	[1]40.3	42.2	[1]66.7
T-25	[2]48.8	---	---	---
T-44	---	[1]81.1	[1]59.2	52.8
T-70	[2]49.0	---	---	---
T-196	---	[1]30.9	37.8	[1]57.9
T-208	---	[1]30.2	25.2	[1]57.0
T-469	---	[1]65.2	[1]52.0	48.0
T-595	---	[1]31.5	[1]51.6	47.0

[1]Cultivar mean $\leq$ 67.0 percent of the race stock mean.
[2]Race stock mean significantly higher than that of DPL-16 at the 0.05 level.

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